98/03221 Scaling characteristics of aerodynamics, heat transfer, and pollutant emissions in industrial flames
Weber, R. *Symp. (Int.) Combust., [Proc.]*, 1996, 26, (2), 3343–3354.
From the point of view of fluid flow, heat transfer and pollutant emissions, the knowledge required for successful scaling of small-scale flames into industrial ones has been reviewed. Constant velocity and constant residence time scaling criteria have been scrutinized for their applicability in engineering of gaseous, spray-oil and pulverized coal flames. Both seem to have limitations and, in particular when applying to two-phase combustion, there appear to be considerable difficulties in scaling of the interactions between the gaseous and solid (liquid) phases. Specific considerations are given to scaling natural gas flames spanning the thermal input range of 7–14 MW. A methodology derived for scaling of the emission data with heat extraction has been used to quantify the spread in the NO_x correlation of Rokke *et al.* To make the derived correlations applicable to industrial situations, it is necessary to include the important effects of flue gas entrainment through the external (in-furnace) recirculation zone. In addition to the radiant fraction, another scaling parameter accounting for the radiation losses from the post-flame region is needed. Rapidly developing new combustion technologies require scaling considerations on (1) flame-flame interactions and (2) steady and transient combustion of small quantities of fuel gas and air both injected into hot combustion products.

98/03222 Stimulation and implementation of laminar flow reactors for the study of combustion systems of ethane, methane and deborane
Yossefi, D. *et al. Fuel*, 1998, 77, (3), 173–181.
Combustion systems in laminar flow reactors can be simulated with a physical model developed for the purpose. The model is one-dimensional, includes transport phenomena and is derived from conservation equations and thermodynamic relations. The model facilitates the accurate prediction of chemical time. A numerical programme, LIOR, has been developed for solving the governing equations and coupled with both CREMKIN, an advanced package designed to facilitate simulations of elementary chemical reactions, and with TRANSPORT, a package capable of evaluating the transport property coefficients. The numerical code has been validated via the simulation of ethane combustion. The results were compared to available experimental results and good agreement was discovered. The model has been used to examine methane (CH_4) and ethane combustion in a synthetic atmosphere system where nitrogen is replaced as a diluent with carbon dioxide. Under such conditions, where there is a large concentration of carbon dioxide, the chemistry effects are very important. The typical area of application of this work is sub-sea vehicles and other closed-environment machines. The model also served a study aimed at elucidating the oxidation mechanism of the energy enriched fuel, deborane. The results obtained can provide the basis for further investigation of this mechanism.

98/03223 A study on the importance of dependent radiative effects in determining the spectral and total emittance of particulate ash deposits in pulverized fuel fired furnaces
Bhattacharya, S. P. *et al. Chemical Engineering and Processing*, 1997, 36, (6), 423–432.
The results of an experimental and theoretical investigation on the importance of dependent effects in determining the emittance of ash deposits are presented. In order to predict the spectral emittance of semi-transparent and opaque particulate deposits without considering dependent effects, a model has been developed. Predictions from this model have been presented to illustrate the effects of particle size and composition. Hemispherical transmission and reflection measurements have been performed on semi-transparent and opaque particular deposits over a wavelength range typical of PF fired furnaces and spectral emittance has been deduced therefrom. With composition and size similar to ash deposits formed in PF fired furnaces, slag particles were used in the measurements. In terms of emittance, the difference between the model predictions and measurements for the opaque deposit have been found to be significant at wavelengths up to 7μm. This difference is believed to be largely due to dependent effects. The authors recommend more experiments to quantify the effects.

98/03224 Thermogravimetric analysis on copyrolysis of coal and coke-oven gas. II. Combustion reactivity of chars from coal copyrolysis with coke-oven gas
Liao, H. *et al. Ranliao Huaxue Xuebao*, 1997, 25, (6), 544–548. (In Chinese)
The co-pyrolysis behaviour of three Chinese coals with real coke-oven gas (COG) was investigated in detail by using thermogravimetric analysis (TGA) and compared with hydropyrolysis under comparable conditions. Results indicated that the reaction pressure and heating rate have significant effects on co-pyrolysis behaviour. With a raising pressure and a decreasing heating rate the total conversion increases. There is a co-effect on co-pyrolysis between pressure and heating rate, by decreasing the heating rate, higher conversion can be obtained at low pressure than at high pressure with high heating rate. High pressure and low heating rate can be used to increase the total conversion of the co-pyrolysis. Compared with hydropyrolysis under comparable conditions, the total conversion of the co-pyrolysis slightly decreases and the peak temperatures in DTG move toward the low temperature region.

98/03225 A transient two-dimensional chemically reactive flow model: fuel particle combustion in a non-quiescent environment
Lee, J. *et al. Symp. (Int.) Combust., [Proc.]*, 1996, 26, (2), 3059–3065.
Based on the spectral element method, a numerical method has been developed for simulating transient two-dimensional chemical reactive flows. It is not only capable of including realistic transport and chemical kinetics, but is also sufficiently flexible to model combustion systems in various complex geometries. For the first time, this numerical method has enabled the two-dimensional transient solutions of two different fuel particle combustion problems in a non-quiescent environment that includes coupled convection, detailed molecular transport and elemental chemical kinetics. The effects of low Reynolds number flow on the ignition and flame structure development of a spherical non-premixed CO/air flame and on the gasification behaviour of a small carbon particle were revealed through the simulation.

10 ENGINES

Power Generation and Propulsion, Electrical Vehicles

98/03226 Advanced integration concepts for oxygen plants and gas turbines in gasification/GCC facilities
Smith, A. R. *et al. Proc. Annu. Int. Pittsburgh Coal Conf.*, 1996, 13, (1), 421–426.
Concepts involving the integration of a cryogenic air separation unit (ASU) with the gas turbine combined-cycle module have aided the commercialization of integrated gasification combined cycle (IGCC) power. Basic integration principles and advanced concepts based on emerging high compression ratio gas turbine, humid air turbine cycles and integration of compression heat and refrigeration source from the ASU (air separation unit) are discussed.

98/03227 The ANU solar thermal steam engine: performance analysis
Bannister, P. *Int. J. Energy Res.*, 1998, 22, (4), 303–316.
The results are reported from a series of experiments performed to define the performance of the uniflow piston-operated valve steam engine developed by the Australian National University (ANU) for solar thermal applications. The results are fitted by least-squares regression to simple power series expressions that correlate the power output and engine inlet pressure to steam temperature, thermal power input and condenser pressure. The engine performance was examined via a comparison with an idealized frictionless and quasi-static model. The idealized model is used to assess the relative importance of the effects of friction and non equilibrium thermodynamic conditions in the engine. The exergetic performance of the ideal engine is examined to demonstrate the fundamental limitations of this engine technology. It is concluded that high piston/cylinder forces during the first stages of expansion pose a significant barrier to the enhancement of engine efficiency through the use of higher temperatures and expansion ratios.

98/03228 Biogas engine with drive gas purifier and catalytic exhaust gas treatment
Gruber, F. and Melmer, E. Eur. Pat. Appl. EP 818,617 (Cl. F02B43/00), 14 Jan 1998, AT Appl. 96/1,245, 11 Jul 1996, 7 pp. (In German)
An engine with an exhaust gas catalyst in the exhaust line, an adsorber for adsorptive purification of the drive gas, a regenerator for the adsorbent using preheated combustible gases, especially the drive gas and a torch comprise the gas motor. A biogas drives the engine, a digester or clarifier gas or a landfill gas, for example. A porous steam-activated carbon based on coal is used for the adsorbent, which is suitable for removing organic silicon compounds. The activated carbon has a packing density of 400–600 kg/m^3. In the regenerator, an electric heater heats the bed to 350–450°C and it is cooled by a blower.

98/03229 Compact methanol reformer test for fuel-cell powered light-duty vehicles
Emonts, B. *et al. J. Power Sources*, 1998, 71, (1/2), 288–293.
An attractive option as energy conversion unit for light-duty vehicles is on-board production of hydrogen from methanol based on a team reformer in connection with the use of low-temperature fuel-cells (PEMFC). A steam reforming process at higher pressures with an external burner offers advantages in comparison to a steam reformer with integrated partial oxidation in terms of total efficiency for electricity production. The main aim of a common project carried out by the Forschungszentrum Julich (FZJ), Haldor Topsøe A/S (HTAS) and Siemens AG is to design, to construct and to test a steam reformer reactor concept (HTAS) with external catalytic burner (FZJ) as heat source. Catalysts for heteroge-